Miniature polymer electrolyte membrane fuel cell, used in microsystems, has a structure produced by a combination of thin film, microsystem etching and glass-silicon bonding technologies

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Abstract of **DE19914681**

A microsystem polymer electrolyte membrane (PEM) fuel cell is produced by a combination of thin film, microsystem etching and glass/silicon bonding technology. A microsystem PEM fuel cell comprises a complete fuel cell structure which is produced by a thin film process on porous membranes formed in a silicon substrate by a microsystem technology etching process, and which comprises a plasma polymerized membrane, two catalyst metal-doped porous graphite layers and elements for connecting the structure to parallel produced structures, the structure allowing spatially separate and uniform supply of fuel from both sides by means of a glass/silicon bonding technique.

DERWENT-ACC-NO: **2000-665953**

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TITLE: Miniature polymer electrolyte membrane fuel cell, used in microsystems, has a structure produced by a combination of thin film, microsystem etching and glass-silicon bonding technologies

INVENTOR: MEX, L; MUELLER, J

PATENT-ASSIGNEE: MEX L[MEXLI] , MUELLER J[MUELI]

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PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
DE 19914681 A1	October 5, 2000	N/A	004	H01M 008/02
DE 19914681 C2	July 18, 2002	N/A	000	H01M 008/02

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
DE 19914681A1	N/A	1999DE-1014681	March 31, 1999
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ABSTRACTED-PUB-NO: DE 19914681A

BASIC-ABSTRACT:

NOVELTY - A microsystem polymer electrolyte membrane (PEM) fuel cell is produced by a combination of thin film, microsystem etching and glass/silicon bonding technology.

DETAILED DESCRIPTION - A microsystem PEM fuel cell comprises a complete fuel cell structure which is produced by a thin film process on porous membranes formed in a silicon substrate by a microsystem technology etching process, and which comprises a plasma polymerized membrane, two catalyst metal-doped porous graphite layers and elements for connecting the structure to parallel produced structures, the structure allowing spatially separate and uniform supply of fuel from both sides by means of a glass/silicon bonding technique.

USE - As a miniaturized PEM fuel cell used in microsystem technology.

ADVANTAGE - The advantages of microsystem technology and a combination of silicon microstructuring technology, thin film processes, glass etching technology and silicon/glass bonding technology are combined to allow formation of a planar system of fuel cells connected in parallel and in series, as desired.

DESCRIPTION OF DRAWING(S) - The drawing shows a PEM fuel cell microsystem in accordance with the invention.

n-Conducting silicon substrate 1

p-Conducting cover layer 2

Fuel cell 3

Porous p-conducting layer 4

Catalyst metal-doped graphite layers 5, 7

Polymer membrane 6

Metallizations 8

Fuel supply capillaries 9

Cavity 10

Glass substrate 11

CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS: MINIATURE POLYMER ELECTROLYTIC MEMBRANE FUEL CELL MICROSYSTEM
STRUCTURE PRODUCE COMBINATION THIN FILM MICROSYSTEM ETCH GLASS SILICON BOND

DERWENT-CLASS: A14 A85 L03 X16

CPI-CODES: A04-A; A04-E10A; A10-B01; A12-E06B; L03-E04; L04-A01; L04-C02; L04-C15;

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ENHANCED-POLYMER-INDEXING:
Polymer Index [1.1]
018 ; R00339 G0544 G0022 D01 D12 D10 D51 D53 D58 D69 D82 F* 7A ; G0806 G0022 D01 D51 D53 D12 D10 D58 D60 D82 P* 5A O* 6A ; H0022 H0011 ; L9999 L2528 L2506 ; L9999 L2619 L2506
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SECONDARY-ACC-NO:
CPI Secondary Accession Numbers: C2000-201903
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In English:

The invention concerns the structure of a miniaturized PEM (Polymer electrolyte Membran) gas cell in micro system engineering, which consists thin section diaphragm electrodes of a unit and a silicon carrier with porous silicon structures as well as hermetically closely with the silicon connected glasabdeckungen. Such a structure permits an integration due to the compatibility with usual mikrosystemen not only in principle into such mikrosysteme. Due to the high electrical and thermal conductivity of the silicon as well as the established, hermetically seal connection of silicon glass, e.g. by anodic bonding, and to the possibility, silicon by drying and wet-chemical procedures economically of structuring reproducibly and with high accuracy and of combining with thin section procedures, this structure opens also simple possibilities for the parallel and row interconnecting as well as for and removal. At present gas cells, in particular PEM cells, realized on the basis embedded by layer piles from the ion-leading diaphragm, between two porous graphite electrodes coated with catalysts, which are locked by sheet metals with channels to the fuel supply. While a series connection of cells at not insignificant material and assembly expenditure is possible in a stack arrangement in this way (US 5.858.569 A), is a series connection in one level in principle possible and also in the meantime realizes (e.g. DE 44 43 945 c1, DE 195 02 391 c1), to use however without the possible technological solutions of integrated systems for instance from the micro system engineering. A special interest in a simplified structure of gas cells with small space requirement exists for their application as energy source in portable kleinverbrauchern, e.g. portable computers, Videocameras, telephones and similar devices. Apart from a space-saving arrangement of gas cells in one level the use of thin section diaphragms and electrodes is favourably and also already admits for the necessary miniaturization of gas cells (DE 196 24 887 A1, DE 195 13 292 c1). These systems contain however elements, in particular their housings, which are not compatible with the thin section procedures and therefore need a increased assembly expenditure. Besides a further disadvantage results in the characteristics of the gas cell with the thin section diaphragms described there: The ion-leading thin sections in DE 195 13 292 c1 are made of different fluorine coal materials in connection with tri fluorine methane sulfone acid. When using tri fluorine methane sulfone acid it comes in the plasma due to the comparable binding energy between the carbon/sulfur connection and the connections in the sulfone acid also to fragmenting the sulfone acid. Thereby either high-interlaced polymers with very small ionic conductivity, resulting in increased cell internal resistances, develop or polymers with sufficient ionic conductivity however small cross-linking degree and high portion does not kovalent to the polymer stand of bound tri fluorine methane sulfone acid (see in addition: Ber. Bunsenges. Physical chem. one, Bd 98 (1994), pages 631 to 635). Latter layers are long-term stable therefore not and possess in particular due to the small cross-linking degree with the use in directly methanol gas cells high permeation rates of the used fuels, which lead to losses of the gas cell.

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Die Erfindung betrifft den Aufbau einer
miniaturisierten PEM-(Polymer-Elektrolyt-
Membran)-Brennstoffzelle in
Mikrosystemtechnik, die aus einer Dünnschicht-
Membran-Elektroden Einheit und einem Silizium-
Träger mit porösen Siliziumstrukturen sowie
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Babel Fish Translation

In English:

The plasma polymerization of ion-leading layers out e.g. ethyls and groups of carboxylates (DE 196 24 887 A1) possesses the disadvantage of the use of a weakly sour group of carboxylates, which leads to small ionic conductivity. Besides these plasma polymers contain aliphatic hydrogen atoms, which attack places for an oxidative dismantling are. The disadvantages mentioned become in the available invention by a simple structure of a miniaturized gas cell in accordance with Abb. 1 solved, which consists porous silicon ranges of a silicon carrier 1, contains of the 4 and endowed themselves on that one with catalyst, preferably Pt and Pt/Ru, graphite thin section 5, a ion-leading thin section polymer diaphragm 6, which one is from a teflon-like matrix with integrated ion leader chains, e.g. phosphorus or groups of sulfuric acids, CO-PLASMA-POLYMERIZED diaphragm and again one endowed graphite thin section 7 with catalyst finds. The lower graphite layer 5 as well as the diaphragm 6 are according to Abb. 1 structures laid out, then through structured interpretation can be attained the upper graphite layer 7 a direct interconnecting of the cells in row according to. For galvanic separation of the single cells in the level a p-leading thin section 2 between these is arranged, so that with the silicon substrate p-n junctions result. The minimization of the row resistance those become individual cells in accordance with Abb. 2 preferably as narrow rigid ones implemented. In addition the not necessarily porous ranges can contain additional thin section metallizations 8 of the cell outside of the active ranges. The silicon carrier with thin section diaphragm electrodes unit is hermetically closely outward locked by glass substrates (fig. 1, 11). The glass substrates are here favourably in their thermal coefficients of expansion that of the silicon adapted (e.g. Tempax or Pyrex). For an even supply of the fuels from both sides the glass substrates contain recesses ago of the diaphragm for the gasfuehrung and distribution. The supply of the fuels is made by capillaries 9 into the cavities 10 of the glass substrates 11. Due to the high heat conductivity and small thermal capacity of the silicon and the small thermal conduction in the glass such a cell reaches fast its operating temperature, without its environment is affected substantially of it. A favourable execution of the arrangement according to invention is the use of one from Fluorethen and Vinylphosphonsaeure CO-PLASMA-POLYMERIZED thin section diaphragm. Into the Vinylphosphonsaeure existing C/C double bond makes a kovalenten installation for the phosphonic acid possible into the polymer stand without fragmenting the groups of phosphonic acids. Thereby this CO-PLASMA-POLYMERIZED thin section diaphragm is chemical and temperature stable with high ionic conductivity with at the same time high cross-linking degree. The high cross-linking degree causes besides a locking action for fuels, e.g. methanol, so that additional fuel barrier layers from Pd or Pd/Ag alloys are not necessary (see e.g. to DE 196 46 487 C2 and DE 197 34 634 c1). These characteristics of the thin section diaphragm lead to a clear improvement of the losses in gas cells.

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Die Plasmapolymerisation ionenleitender
Schichten aus z. B. Ethylen und
Carboxylatgruppen (DE 196 24 887 A1) besitzt
den Nachteil der Verwendung einer schwach
sauren Carboxylatgruppe, welches zu geringer
Ionenleitfähigkeit führt. Zudem enthalten
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Babel Fish Translation

In English:

1. PEM gas cell system in micro system engineering, by the fact characterized that a) in a glass silicon glass layer group the structure of a complete system from PEM gas cells realized is, to which on porous carrier diaphragms produced in the silicon substrate a complete gas cell in each case is arranged, those of two with catalyst metals, in particular with Pt and/or Pt-Ru endowed, porous graphite thin sections and a ion-leading thin section polymer electrolyte diaphragm lying between them consists, whereby for serial or parallel interconnecting of the individual gas cells among themselves between the individual gas cells elements from conductive silicon as well as conductive strip structures with galvanic separation of the single cells are arranged in the level over pn of transitions in the silicon that b) the glass substrates recesses for gasfuehrung and gas distribution for the spatially separated supply of the fuels on both sides of the thin section polymer electrolyte diaphragm contain that c) the glass substrates with between them arranged the silicon layer it is hermetically closely connected that d) into the thin section polymer diaphragm ion-leading groups, in particular phosphorus or groups of sulfuric acids, over the co-Polymerisation by on fluorocarbons which are based precursor compounds and monomers under education of a ion-leading electrolyte diaphragm are merged. 2. PEM gas cell system in micro system engineering according to requirement 1, by the fact characterized that the thin section polymer diaphragm is a ion-leading electrolyte diaphragm received by CO-Polymeristaion from Fluorethen and Vinylphosphonsaeure. 3. PEM gas cell system in micro system engineering according to requirement 1 or 2, by the fact characterized that the coefficient of expansion of the glass used for locking is adapted to silicon at the coefficients of expansion. 4. PEM gas cell system in micro system engineering according to requirement 1 to 3, by it characterized that the fuel supply is made by lateral openings in the glass, into which prefers capillaries are inserted. 5. PEM gas cell system in micro system engineering according to requirement 1 to 4; by the fact characterized that the gas cells of the gas cell system are streifenfoermig trained. 6. PEM gas cell system in micro system engineering according to requirement 1 to 5, by the fact characterized that electrical contacting for a row interconnecting takes place along the broadsides of the gas cells. 7. PEM gas cell system in micro system engineering according to requirement 1 to 6, by the fact characterized that electrical contacting for a parallel connection takes place along the narrow sides of the gas cells. 8. PEM gas cell system in micro system engineering according to requirement 1 to by the fact 4 characterized that the electrical connection of the individual gas cells is made by structured thin layers.

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1. PEM-Brennstoffzellensystem in
Mikrosystemtechnik, dadurch gekennzeichnet,
dass

a) in einem Glas-Silizium-Glas-Schichtverbund
der Aufbau eines vollständigen Systems aus PEM-
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